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PROGRESS REPORT No.5
A STUDY OF STATE HIGHWAY NEEDS IN INDIANA

DECEMBER, 1956
No. 39

by

H.L. Michael
A.K. Branham
D.O. Covault

Joint Highway Research Project

PURDUE UNIVERSITY
LAFAYETTE INDIANA

Progress Report No. 5 on

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Purdue University

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December [illegible], 1956

Lafayette, Indiana

PROGRESS REPORT NO. 5 ON
STATE HIGHWAY NEEDS IN INDIANA

To: K. B. Woods, Director
Joint Highway Research Project

December 5, 1956

From: Harold L. Michael, Assistant Director

File: 3-3-20
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Attached is the fifth report on the progress of the Indiana Highway Needs Study. This report essentially consists of background information concerning the highway problem, a general description of the method of analysis of the state highway inventory information gathered in the winter and spring of 1955, and a statement as to total needs for a 15 year program computed for the state and county highways and city streets.

The information in this report will be released to the Indiana Highway Study Commission under the chairmanship of S. Paul Clay, Jr., so that it will be available for study by the legislature.

Respectfully submitted,

Harold L Michael
(By Donald O Cornell)

Harold L. Michael, Assistant Director
Joint Highway Research Project

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HIGHWAY NEEDS IN INDIANA

INTRODUCTION

The way of life in America has been changed significantly by the development of the automobile and with the improvement of the road and street systems. The nation, every state, city, and village and life within the broad expanse of the rural area has felt the impact of highway transportation. Fifty years ago old dobbin and the buckboard were symbols of highway transportation and community life was centered around the general store, the church, and the little red school house. Each community, except for the newspaper and the railroad, was isolated from its neighbor.

Fifty years ago highway motor vehicles were a curiosity and a luxury and the roads often were impassable. By 1906, the number of motor vehicle registrations was about one vehicle for every 700 residents of the nation. But intercity travel was restricted to the limited mileage of "all weather" roads. By 1956, the nation had one motor vehicle for every 3.3 persons and 62 percent of the nation's rural highways had all weather surfaces.

A similar pattern of growth may be observed in Indiana. In 1906, Indiana had about one motor vehicle for every 1000 persons. Their number had increased to one vehicle for every 3 residents in 1956. Indiana had only a few miles of all weather roads in 1906; by 1956 over 90 percent of the road mileage was in this classification. But a large percentage of this mileage is inadequate for current and future traffic.

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Today, the residents of Indiana and of the nation are on the move. With the sprawling cities and suburbs, shopping centers and drive-ins, consolidated schools, motels and trailers, and improved recreational areas, the population has become a nation on wheels. On wheels they go to work, to school, shopping, and on vacation. Every 24 hours they travel nearly two billion miles on the highway not to mention travel by other forms of transportation. The "end of the line" has disappeared. They go everywhere by road and the automobile.

Increase in Motor Vehicles

At the end of World War II about 31 million motor vehicles were on the roads of America; their number had doubled by 1956. Likewise, their number nearly doubled in Indiana - from about one million to nearly two million motor vehicles. But this is not the end of the line for predictions show that 85 to 100 million motor vehicles will be on the nation's highways in 1980. And, if the present trend continues, Indiana may have three million vehicles by 1970 and about four million by 1980. This growth in Indiana is illustrated in Figure I.

Traffic Volumes

As registration increases so does traffic volume and congestion. In 1940 the annual travel on the nation's highways was about 300 billion vehicle miles, by 1956 it was nearly 600 billion, and by 1980 it may double. In 1940 motor vehicles traveled about 9 billion miles on Indiana highways; by 1956 the annual mileage had doubled; and by 1980 the annual vehicle mileage may double again. Figure 2 indicates the recent growth and expected growth of motor vehicle traffic volumes in Indiana.

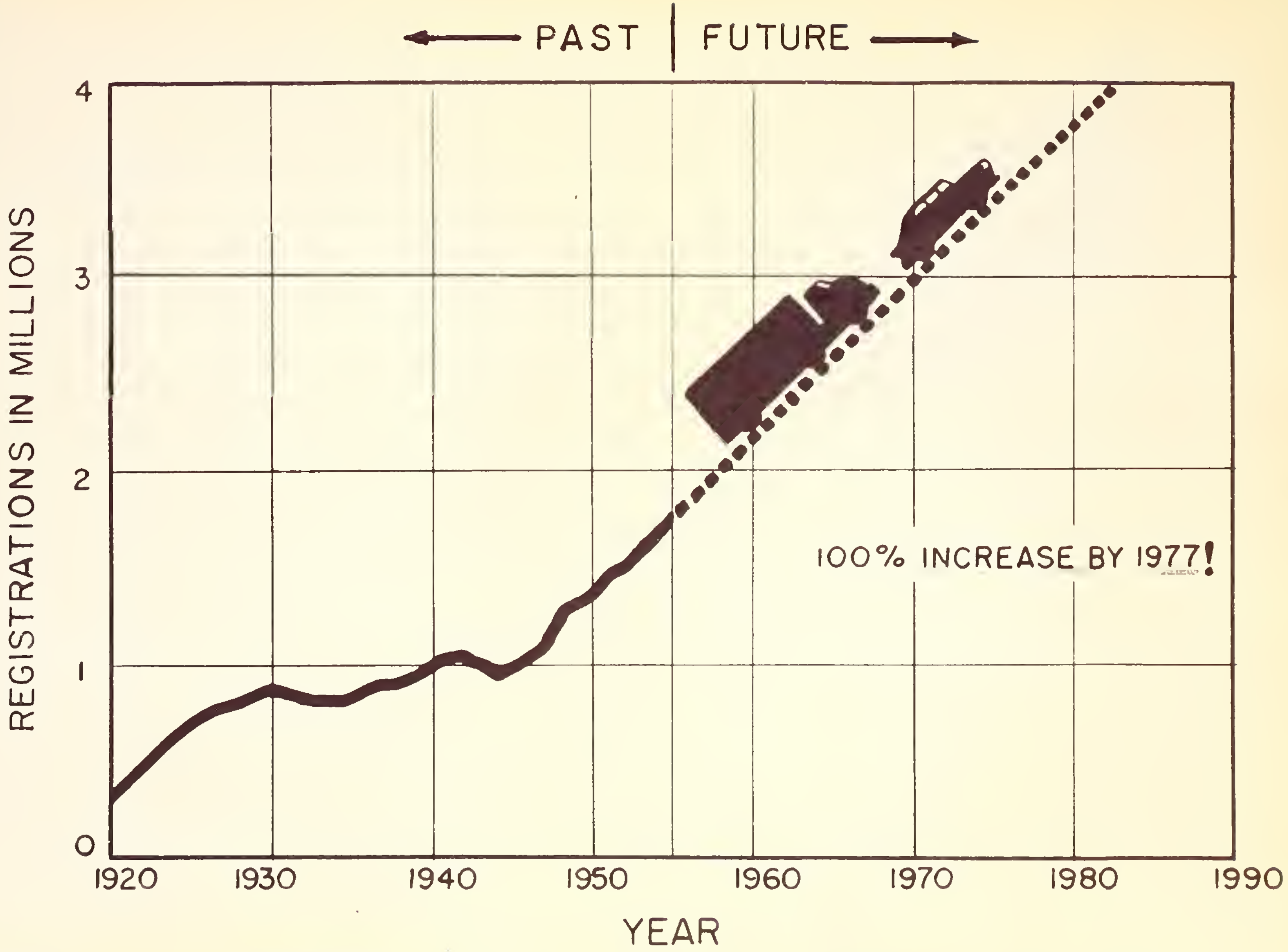


FIGURE I **MOTOR VEHICLE REGISTRATION IN INDIANA**

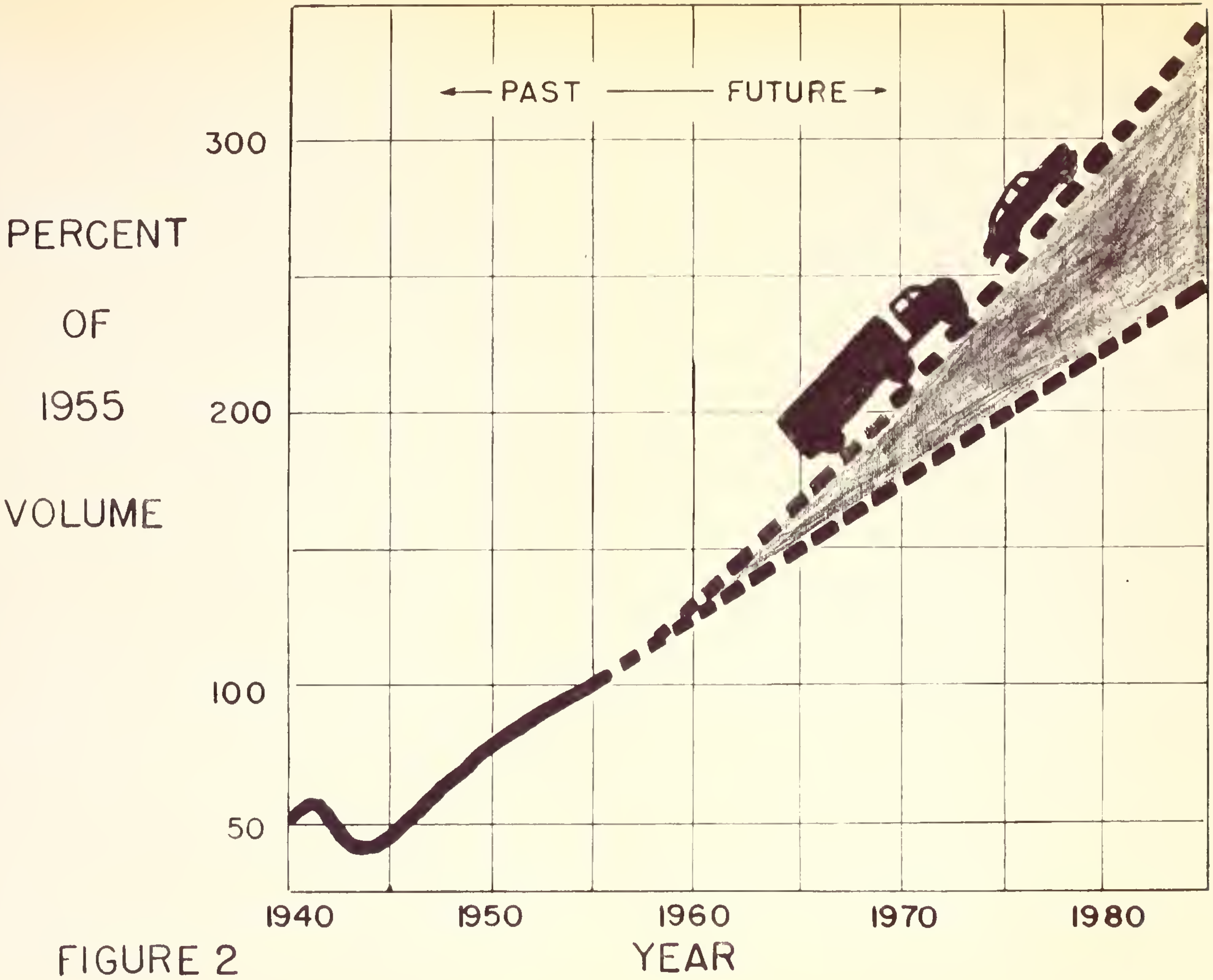


FIGURE 2

GROWTH OF TRAFFIC

Population Growth

Population is increasing rapidly. The nation's population increased from 108 million in 1921 to over 165 million in 1956. By 1970, it is expected to be over 200 million and by 1980 it may approach 250 million. The intensification of the highway transportation problem in the United States is reflected in the projected growth figures for the nation as a whole. But it becomes more pronounced when growth in urban areas is considered. From 1940 to 1950, when population increased by 19 million, 80 percent of the growth took place in the 168 metropolitan areas of the nation. Furthermore, predictions indicate that 134 to 142 million people will reside in urban areas by 1965, and that 146 to 158 million will be there by 1975.

The growth of population in Indiana has been similar to that of the nation. The population of Indiana increased from 3.3 million in 1940 to about 3.8 million in 1950, representing an increase of about 14 percent. And since 1950, Indiana population has increased another 12 percent. Much of the increase was in the urban and suburban areas and population data indicate that this general growth in Indiana will continue in the future.

Gross Nation Product and Income

The gross national product was about $172 billion (in 1947 dollars) in 1940, it was about $319 billion in 1955, and it is expected to double by 1975. Dispesable personal income, on a national basis (1954 prices), increased from $1106 in 1940 to $1561 in 1954, representing an increase of 41 percent. Income payments to individuals in the nation were $575 in 1940 and $1709 in 1953 and income payments to individuals in Indiana were $541 in 1940, $1834 in 1953, and $1894 in 1955. Individual incomes in Indiana have increased about 25 percent since 1950, and several times

this amount since 1940. This prosperity is reflected in motor vehicle ownership.

Motor Vehicle Ownership

About 67 percent of the families of the nation own an automobile, [illegible] percent own two or more. The growth is similar in Indiana. A recent report for Indianapolis, for example, shows that nearly 84 percent of the family units own at least one automobile and 15 percent own more than one automobile.

Highways and the Economy

Highway transportation is an important segment of the American economy. It provides an effective medium for transporting products to distant communities and helps integrate the smallest village with the nation's economy. On a national basis, the highway industry and related activities are reported to provide nearly 10 million jobs and the future need for highway transportation will greatly increase this number. One out of seven Americans earn a living in some phase of highway transportation and one out of every six businesses in the United States is automotive. A recent statement by the U. S. Department of Commerce shows that nearly $24 billion was spent for automobiles and their operation in 1954. The total expenditure for highway transportation is considerably above this figure and is increasing each year.

A substantial fraction of the nation's working force is engaged in the construction, maintenance, and operation of the road and street system. By way of illustration at the state level, Indiana Governments, state and local, in 1955, employed nearly 9000 full time workers in the highway function.

The sales volume of the five major producers of automobiles was about $22.5 billion in 1955 and over a million workmen were employed in the industry. Indiana also makes a significant contribution to the production of automobiles. The amount of federal excise tax paid annually (over $55 million in 1955) by the automotive industry of Indiana represents a measure of the importance of this industry to Indiana. Another $31 million in excise taxes was paid for motor fuel and lubricating oil.

Trucking accounts for nearly 20 percent of the intercity freight ton miles and about 75 percent of the tonnage. More than 90 percent of all intercity passenger transportation is by private auto and bus, over 85 percent by private auto. Recent nationwide surveys show nearly 85 percent of all vacations by families having annual incomes exceeding $5000 are by private auto.

Highways and Defense

Roads are essential to the national defense. President Eisenhower has said: "Next to the manufacture of the most important implements of war as a guarantee of peace through strength, a network of roads is as necessary to defense as it is to our national economy." This importance was amplified by the passage of federal highway legislation in 1956.

DEFICIENCIES IN FUNDS

All is not good with roads. While the traffic has more than doubled since 1945 new construction has fallen far behind, and the cost of construction has increased rapidly. In 1955, the highway dollar purchased only 79 percent as much as it did in 1946 and about one-half as much as it did in 1932. This is illustrated in Figure 3, Purchasing Power of the Highway Construction Dollar. With World War II and motor fuel rationing annual mileage travel dipped. Meanwhile the gross national product soared.

By 1949 vehicle mileage was in step with the gross national product and has been ever since, but even though new highway construction has climbed rapidly ($4.6 billion outlay in 1955) it has never caught up. Much of this lag may be attributed to an inadequate financial policy. For example, in Indiana, the major source of highway revenue, the motor fuel tax, was established in 1929 when the highway dollar would purchase about 50 percent more than today. Increases in income from this source must, therefore, be attributed to the increased use of motor vehicles. Some changes have been made in registration and license fees, but in general there has been little change in the fiscal policy in Indiana. Nearly $100 million in state funds were available in 1955 as illustrated in Figure 4. Of the total funds for 1955, about 55 percent came from the motor fuel tax, 32 percent from registration and license fees and 13 percent from federal aid.

A Highway Research Board report in 1953 shows that the depreciated investment in all highways was about $37 billion. It also indicated that the construction program barely maintained the depreciated investment of 1941. The report further shows the depreciated highway investment had

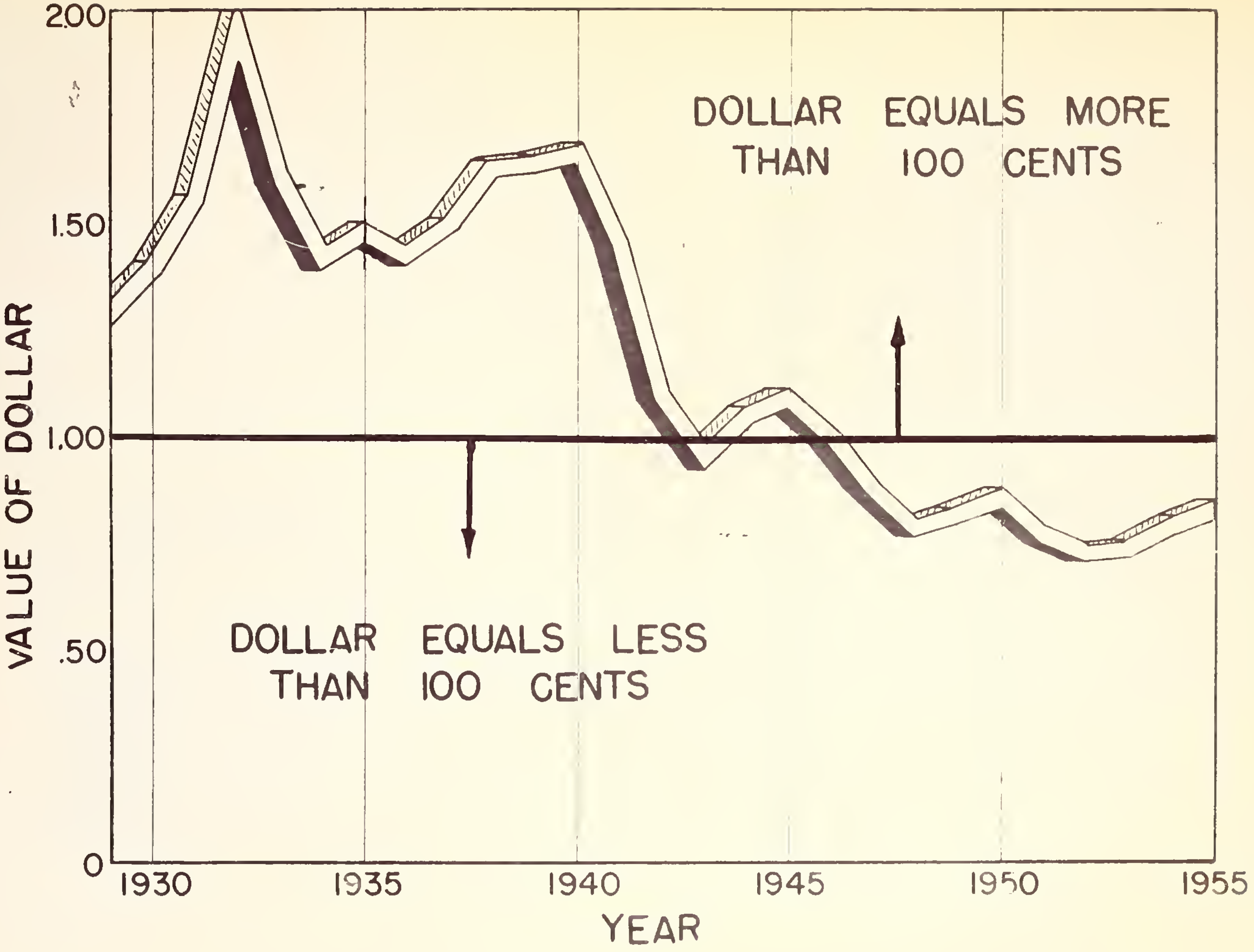


FIGURE 3 PURCHASING POWER OF THE HIGHWAY CONSTRUCTION DOLLAR

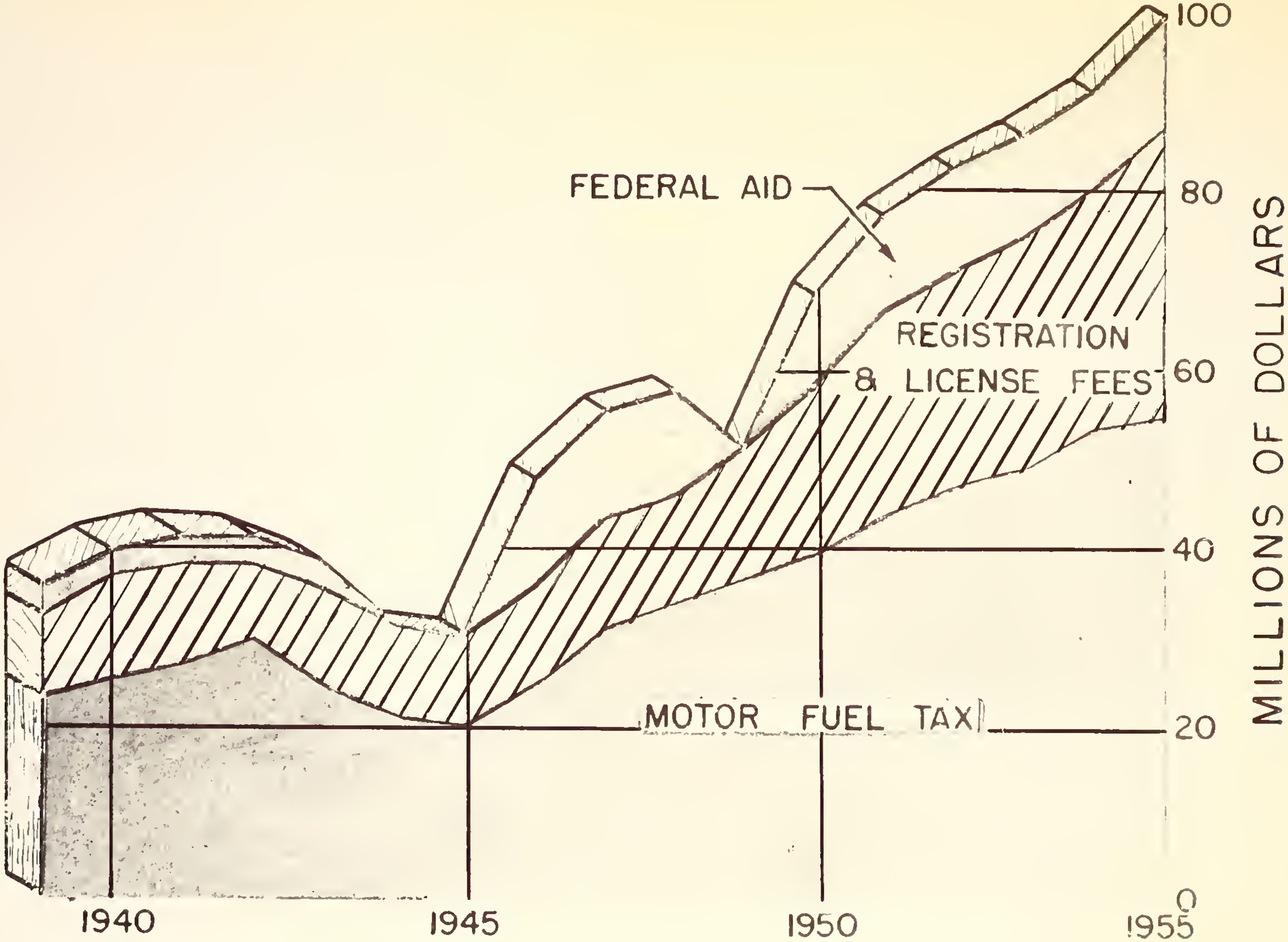


FIGURE 4

MAJOR SOURCES OF REVENUE FOR ALL HIGHWAYS IN INDIANA

dropped to about $691 a car compared to $1064 in 1941. In short, there is now less road per car. This disparity may change significantly in the future because increase in grant in aid funds have become available with the passage of federal legislation in 1956. But the states must develop improved fisical polices to bring this discrepancy into alignment.

EFFECT OF TECHNOLOGICAL DEVELOPMENT

Technological advances in automotive manufacture have out-stripped highway construction. Today's cars are more powerful, are speedier, wider, and longer. Trucks are more powerful, larger, and haul bigger loads. Many of the roads are obsolete for the traffic. Thus, roads are curbing the development of the motor vehicle and vehicle design can only progress in keeping with road improvement.

The Cost of Poor Roads

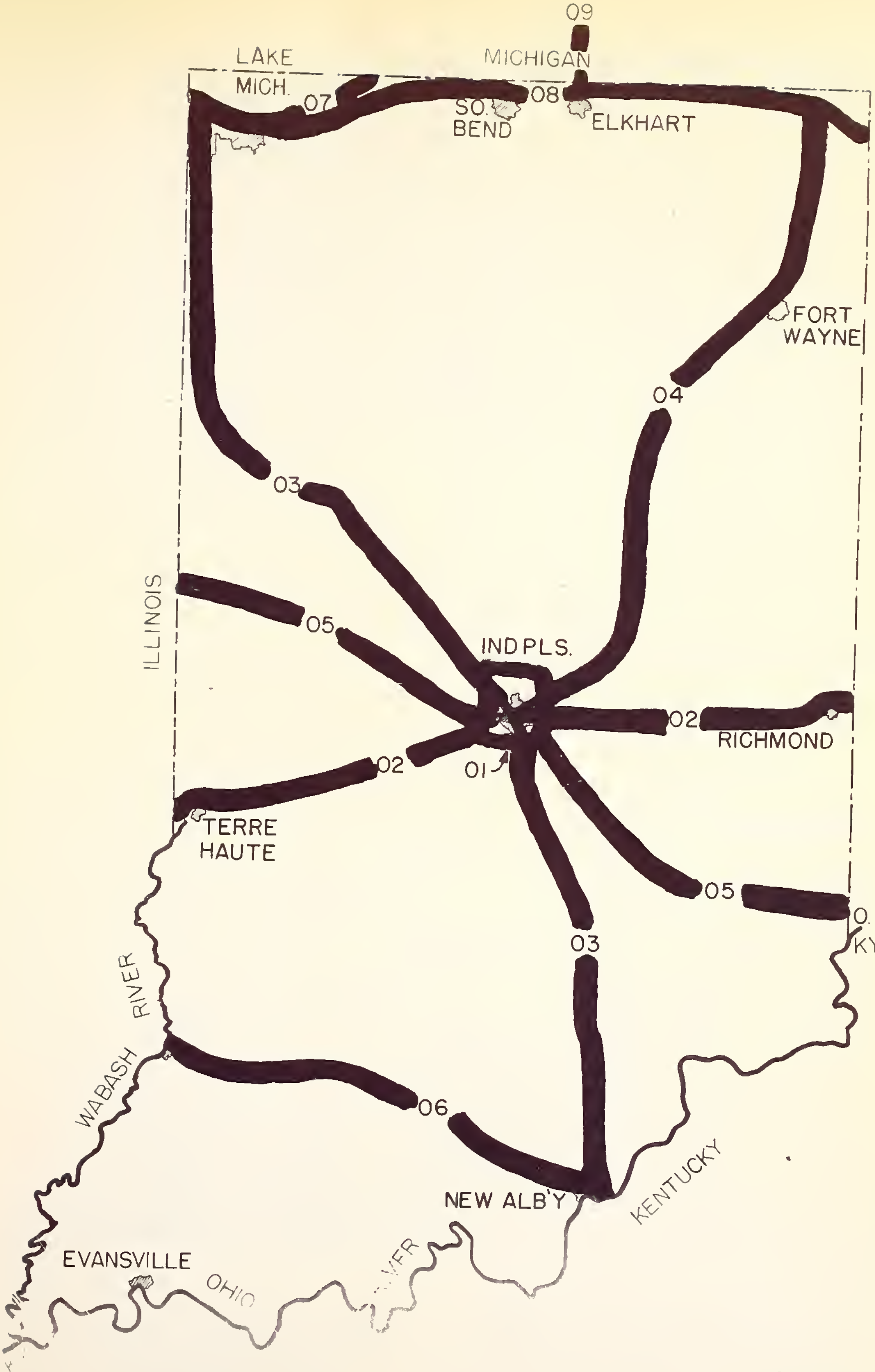
The accident toll is further proof of the need for more and better roads. On a national basis, the death rate per 100 million vehicle miles dropped from 11.3 in 1945 to less than 7 in 1955. But on a population basis the number of fatalities increased about 15 percent in the same period.

Inadequate roads have been estimated to cost the nation's drivers at least $3 billion a year. This includes the extra cost of motor fuel, brakes and tires in traffic congestion, needless accidents, and losses in time in commercial vehicle traffic. Extra money is also spent on increased auto insurance premiums.

THE ROAD SYSTEM

The latest count shows the United States has about 3,360,000 miles of roads and streets, including 350,000 miles of city streets. The federal government does not have administrative control of roads except those in national parks and forests. All other roads are constructed by the states and local units of government. Each state has a state highway organization which plans, designs, builds, and maintains roads within a state administered system. In nearly all states, local roads and streets are the responsibility of the local units of government - cities, towns, counties, and townships. Money used for the road function at the local level often comes from one source - the state motor vehicle fund or similar fund. The financing of local roads in Indiana is representative.

The nation does, however, have what is called the "federal aid" system. This includes a specific network of state, city and local roads and streets financed in part by the federal government. This federal aid network contains about 20 percent of the total mileage of roads and streets, including 41,000 miles in the Interstate System. The latter links all major cities, principal industrial centers, seaports and international boundaries. Nearly 1100 miles of the Interstate System are in Indiana and are presented in Figure 5. In addition to the Interstate System, about 10,000 miles of Primary and Secondary Highways are administered by the state (see Figure 6) and, about 76,000 miles are administered by the counties, and another 11,000 miles are administered by the cities of Indiana.



INTERSTATE SYSTEM

FIGURE 5

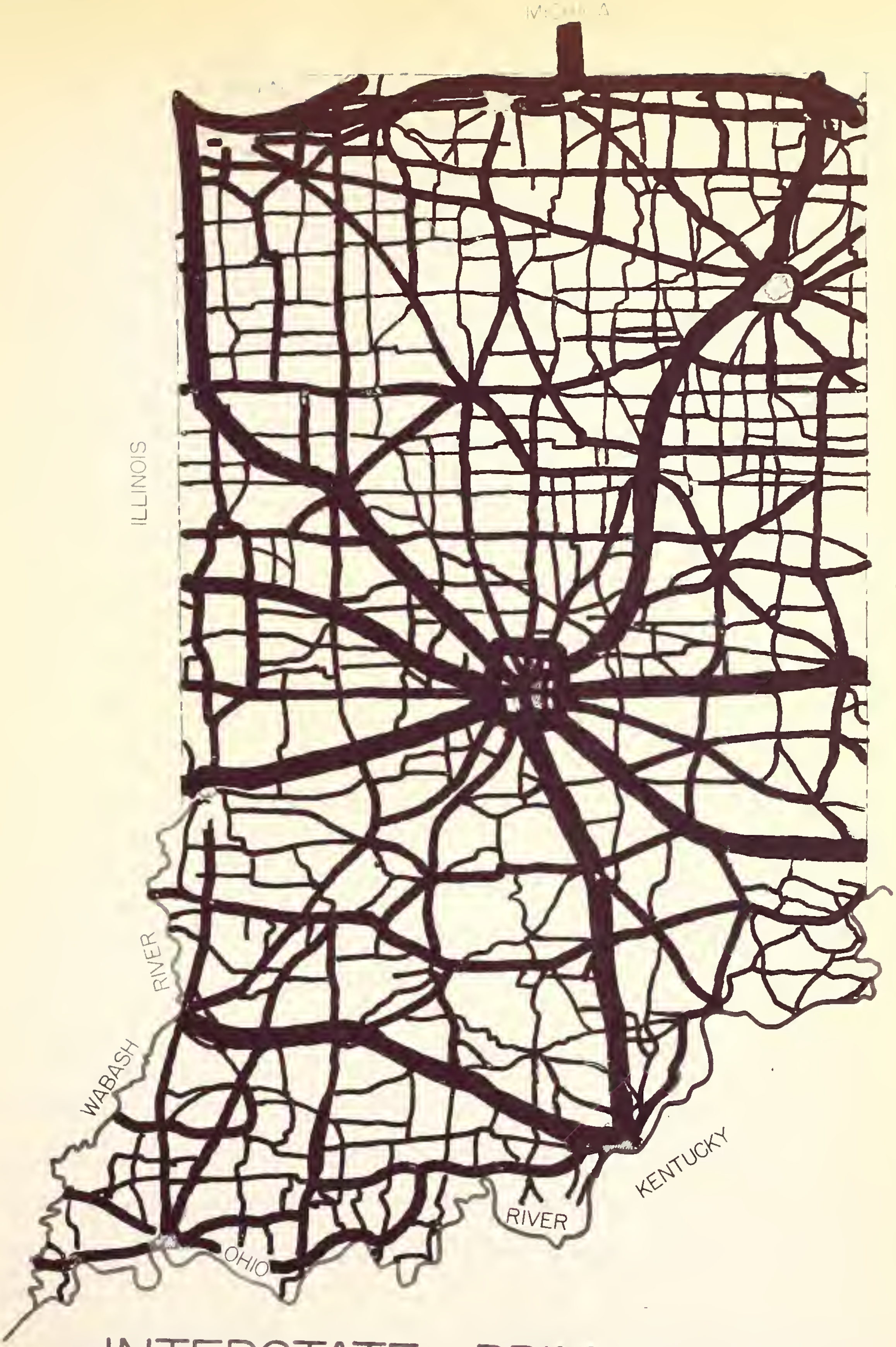


FIGURE 6 INTERSTATE, PRIMARY AND SECONDARY SYSTEM

FINANCIAL POLICY

Over the years, federal grants in aid to the states has been on a 50-50 matching basis. They increased from $5 millinn in 1917 to $200 million in 1938. After falling to practically nothing in the early 1940's, it was resumed at $500 million a year in 1946. In 1954 it was $575 million and by 1956 it was raised to $875 million with about $21 million available to Indiana. The Federal Aid Highway Act of 1956 provided increased funds for the Primary, Secondary and Urban Systems of each state for fiscal years 1957-59. In addition, it provided $25 billion to be expended for the Interstate System in the next 13 years with about 134 million allocated to Indiana for the period 1957-59. The financial responsibility on this System is 90 percent federal and 10 percent state.

In recent years, most of the billions of dollars invested in roads has been paid by the users of the roads. In 1921, 76 percent of the nation's road funds were from property taxes; in 1956, only 21 percent of the road funds came from this source. Nearly everyone has agreed that the most efficient way to raise funds is through highway user imposts - motore fuel taxes and registration fees

By 1929 every state and the District of Columbia had enacted such highway user imposts. Since 1929 these imposts have yielded nearly $40 billion in this country. Zooming traffic abetted by occasional rate hikes have produced a marked uptrend; receipts have more than doubled since 1940 and the current annual income to the states from this source exceeds $4 billion.

Highway users are also liberal contributors to the federal treasury. These excise taxes exceeded $2.7 billion in 1955 and they will increase at

a greater rate in the future because increases have been made necessary to provide funds for allocation under the provisions of the 1956 Federal Aid Highway Act.

Naturally not all the highway user imposts are actually available for highway construction in the states. A substantial part of these receipts must be set aside for maintenance, administration, highway police, and interest payments. In addition, on a national basis, over $200 million is diverted to non-highway purposes each year. On the other hand, several times this amount is allocated from the general funds of the various states for highway purposes.

However, since highway user imposts were originally established for highway purposes, and the need for additional road work is so great, the anti-diverters have received considerable support. More than half of the states now have anti-diversion laws. Indiana does not divert highway funds for non-highway purpose.

One of the basic difficulties in the highway problem of today is concerned with the needs around big cities and on certain other important routes. These routes, which earn much of the revenue because they carry a great amount of traffic, are not always allocated funds in terms of need. Thus funds are dispersed to roads of lesser importance. Consequently the most serious deficiencies are often found on the nation's most congested roads. For example, rural federal aid roads include only 18 percent of the rural road mileage but carry 42 percent of the traffic. Similarly, urban arterial streets account for about 1 percent of the total highway mileage but carry about 39 percent of the total traffic. Together they account for 19 percent of the total road and street mileage but carry 81 percent of the total traffic.

Similarly, the federal government's contribution to highways is not made according to need but according to a strict mathematical formula based on population, area, and road mileage. Some adjustment has been in recent federal legislation, but much remains to be done to accomplish an equitable distribution. Comparable inequalities in distribution at the state level may be observed. One of the critical problems facing highway administrators today is who shall pay and how much.

Another basic error in highway policy concerns the the failure to correct the urban transportation system. Rural roads have for more than 25 years received priority of construction at the expense of urban streets.

Another basic difficulty in much of the road building era has been inadequate planning. The basic objective for many years had been to get the traffic out of the mud, but with the rapid increase in the number of motor vehicles, the issue has been to get them out of the traffic muddle.

PROCEDURE FOR DETERMINING HIGHWAY NEEDS

Although the inadequacy of the system of highways in Indiana is apparent to even the non-motorist, an accurate measure of this inadequacy is desirable. As in a successful business, the highway administrator must know in detail just what he has on hand, what he needs to have to adequately serve the public, and how he can finance the required improvements. A "highway needs inventory" study was, therefore, performed. This study, conducted by the Joint Highway Research Project at Purdue University, has revealed the tremendous highway problem that exists today.

Highway engineers inspected every mile of highway on the State Highway System and collected a great quantity of pertinent inventory information. Type and condition of road surface; the type, quality, and thickness of the pavement; the soil conditions under the pavement; the age of the pavement; drainage; width of pavement and right-of-way; curves, grades, and sight distance; condition, age, adequacy, type of structures, railroad crossing data, and many other items of information were collected and evaluated. The traffic volume on each road section today as well as that expected on the road within the next few years was compared with the capacity of the highway. In addition, structural characteristics and surface life of the pavement were determined. The accident rate on each section for the past two years was determined and roads with high rates were further analyzed.

All of the elements that relate to structural condition, traffic volume capacity, and safety were then analyzed together and the "needs" for each section in the state highway system determined. The actual

conditions existing on each section were evaluated against [illegible] using that highway and a set of minimum standards [illegible]. These minimum standards indicate the minimum road [illegible] that will provide adequate and safe travel for the [illegible]. Anything less would be uneconomical, inefficient, [illegible]ble. The standards for a road depend upon the type [illegible] the road is required to [illegible]. Thus, a road carrying [illegible] a day obviously should not meet the same [illegible] 1000 vehicles a day. Likewise, standards [illegible] of a road that has a daily traffic [illegible] [illegible] 1000 heavy trucks.

These minimum [illegible] standards were [illegible] with each highway [illegible] with the highway [illegible] standards to [illegible] the highway [illegible]. An example of the [illegible] Highway [illegible] County [illegible]. Note the [illegible] steeper grades, [illegible].

Since the [illegible] for each [illegible] the cost of [illegible] the required improvements [illegible]. The sum of these costs for all sections of highway in the state [illegible] represent the [illegible] year in the future [illegible] quate [illegible] improvements [illegible].

As an example of [illegible]

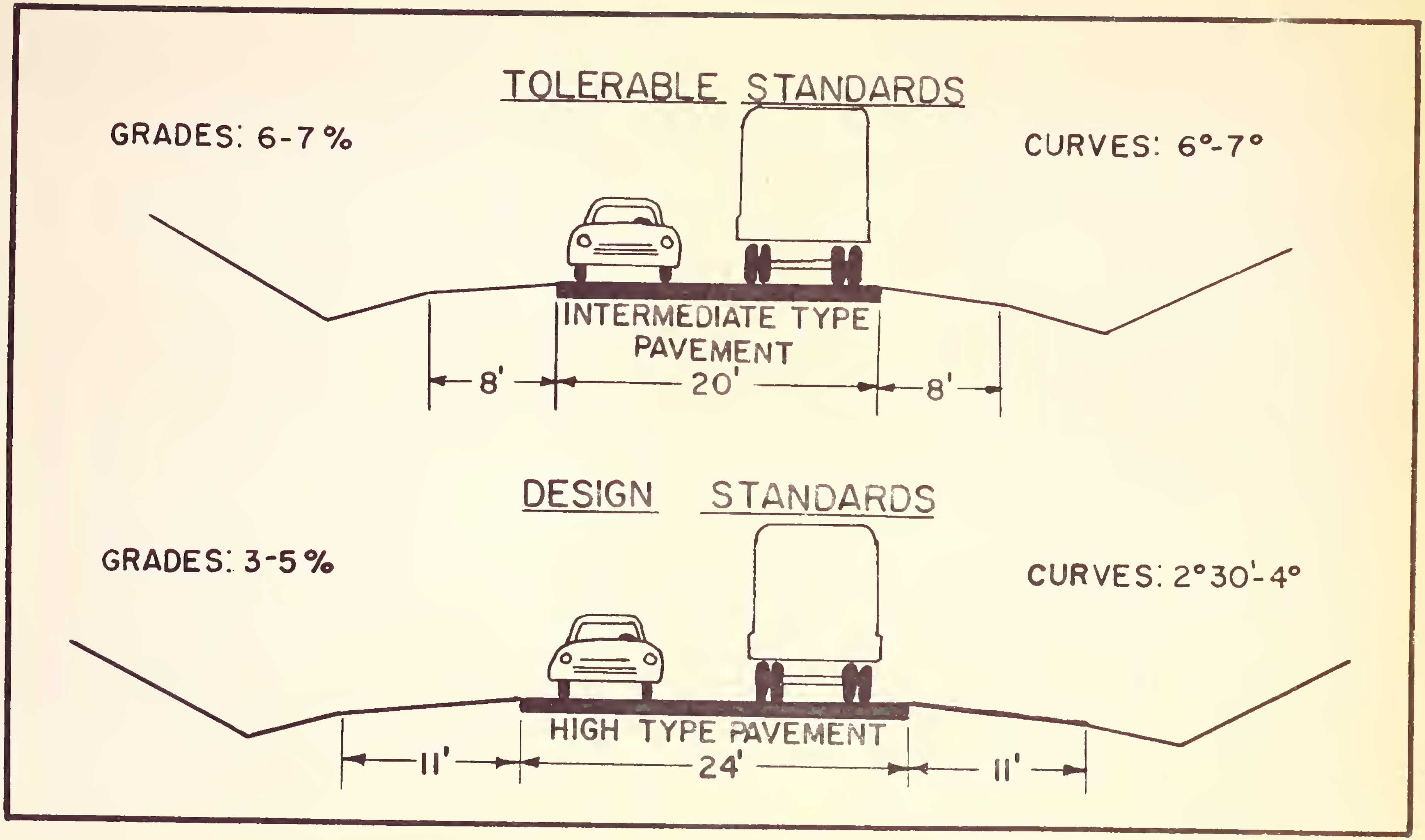


FIGURE 7 COMPARISON OF STANDARDS FOR PRIMARY HIGHWAYS

determined, a section of U. S. 27 in Steuben County will be used. The inventory information, collected by highway engineers of the State Highway Department on special inventory forms provided for this purpose, was coded on IBM punch cards to permit rapid evaluation of the voluminous data. Several cards were necessary for each section of highway and the coding has been arranged so that changes in the highway section can be recorded with a minimum of work as the highway is improved. An accurate and continuing inventory for the highway system is thereby provided, a first requirement of every successful business. One of the IBM cards for the example section is shown in Figure 8. The information printed in the columns at the top of the card gives the code numbers which indicate the location of the section of road on the highway system.

In addition to various tabulations of information, such as the number of miles of highway with inadequate width and the number of narrow bridges, all of the pertinent information for each section of highway was listed and analyzed. This procedure was performed to determine more accurately the actual needs of each section and the type and extent of improvement necessary for each section. In Table I is shown the listing of information and the results of the analysis for the example section on U. S. 27 as well as three other sections (For their location on the State Highway System see Figure 9). Complete information is listed concerning the geometric and structural characteristics of the section, including bridge and railroad crossing protection adequacy. From a comparison with the minimum standards previously discussed, the degree and amount of deficiency was determined. For U. S. 27, traffic volume of 7000, as shown in Column 9, demands a 4-lane divided highway and such improvement is indicated (in Column 23). The information for SR 28 indicates that the

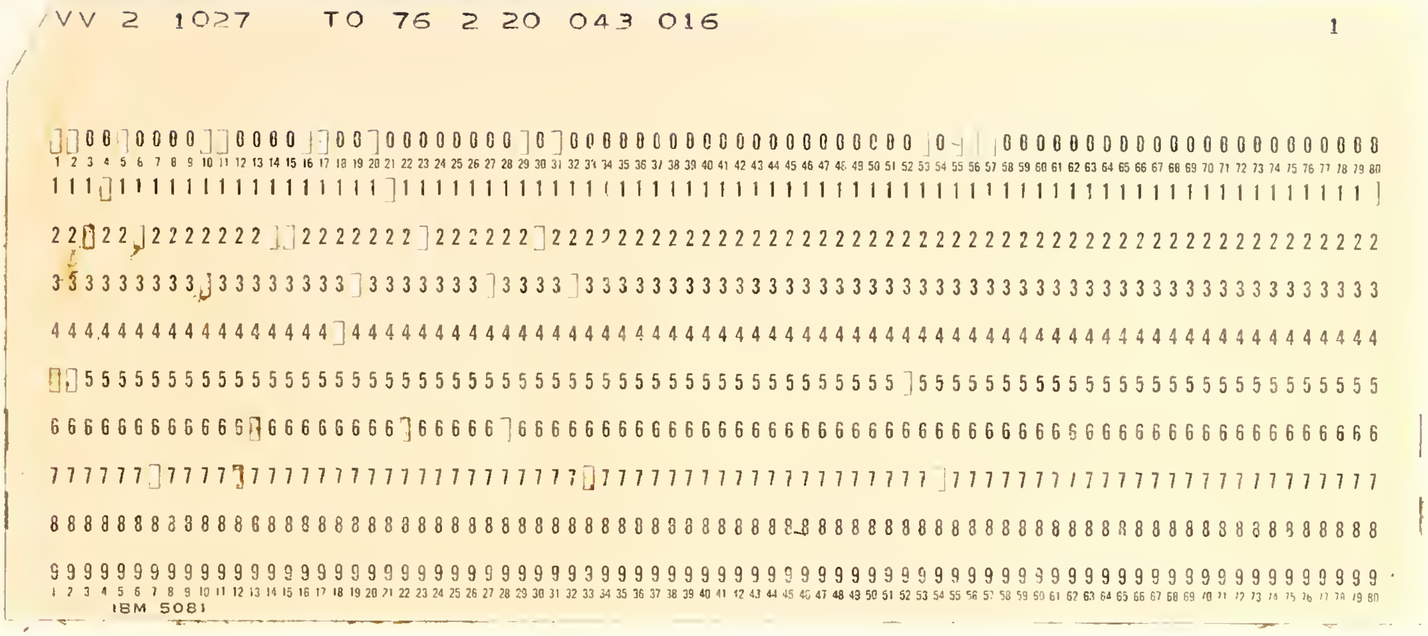


FIGURE 8. IBM PUNCH CARD FOR INDIANA HIGHWAY NEEDS STUDY*

* Each road section has several cards that describe information that pertain to its features. The card illustrated has mainly information concerning the identification and location of the road section and information concerning geometric and structural features of the pavement. In addition each road has a card describing rural or urban features, a card describing each bridge, and a card describing each railroad crossing.

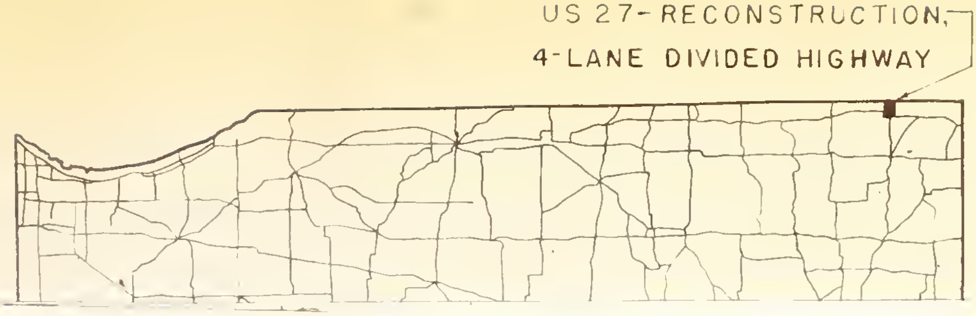

US 27- RECONSTRUCTION,
4-LANE DIVIDED HIGHWAY

TABLE I

SUMMARY OF IBM TABULATIONS

(1) Route Number	(2) Maintenance Section Letter	(3) Subsection Number	(4) Highway District Number	(5) Subsection Length (miles)	(6) Pavement Width (Feet)	(7) Accident Rate (No. Accidents per 100 million vehicle miles)	(8) Capacity (Vehicles per day)	(9) 1955 Traffic (Vehicles per day)	(10) Soil Type	(11) Surface Type	(12) Rigid or Flexible Pavement	(13) Surface Thickness (inches)	(14) Total Thickness or Base Thickness (inches)	(15) Year of Major Construction	(16) Year of Surface Construction	(17) Surface Condition	(18) Shoulder Width (feet)	(19) Curve	(20) Grade	(21) Right-of-way (feet)	(22) Topography	(23) Type of Construction Necessary	(24) Year Improvement Needed
US 27	T	2	Fort Wayne	1.6	20	261	2100	7000	Glacial Drift	Concrete	Rigid	6 0	0 0	1937	1937	Good	11	Continuous curves	3-6%	100	hilly	Reconstruction 4-Lane, divided highway required	
US 27	T	3	Fort Wayne	2.1	20	261	3000	7000	Glacial Drift	Concrete	Rigid	6.0	0 0	1937	1937	Good	11	Some curves	0-3%	100	hilly	Reconstruction 4-Lane, divided highway required	
28	A	1	Crawfordsville	7.5	20	152	4850	1300	Glacial Drift	Concrete	Rigid	9"-7"-9"	—	1934	1934	Poor	10	Some curves	0-3%	80	rolling	Resurface & widen to 24'	
28	A	2	Crawfordsville	6.6	20	152	3500	2300	Glacial Drift	Concrete	Rigid	9"-7"-9"	—	1935	193 -	Poor	10	Some curves	0-3%	80	rolling	Resurface & widen to 24'	

Numbers in color refer to road or bridge features which do not meet minimum acceptable tolerable standards.

RMATION											RAILROAD INFORMATION								COST INFORMATION			
(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)
Bridge Number	Type of Structure	Use or Service	Clear Width (feet)	Length	Number Spans	Footed Loading	Vertical Clearance above high water (feet)	Vertical clearance over stream or highway	Age (years)	Year Bridge Needed	Railroad Name	1955 Traffic x No. of trains	Type of Protection (signals or R.R. sep.)	Year Protection Needed	Highway Construction Costs	Bridge Construction Costs	Right-of-way costs	Railroad Protection Costs (Sig-R.R. sep)	Total Construction Costs	Maintenance Costs	Administration Costs	Total Construction, Maintenance and Administration Costs.
Unknown	Reinforced Concrete slab	Stream Crossing	28	20	1	20	Unknown	Unknown	31						$480,000	$40,000	$80,000	—	$600,000	$2600 per mile per year	6% of construction & maintenance cost	To be determined
															$630,000	—	$105,000	—	$735,000	$2600 per mile per year	6% of construction & maintenance cost	To be determined
28-1-1624 28-1-1272 28-1-1627	Rein. Con. Girder Rein. Con. Girder Rein. Con. Girder	Stream cr. Stream cr. Stream cr.	24 24 24	40 30 36	1 1 1	20 20 20	Unknown Unknown Unknown	10.0 10.0 13.0	22 24 22		New York Central	13,600	Automatic Signals		$270,000	$77,000	$ 9,000	—	$356,000	$1500 per mile per year	6% of construction & maintenance	To be determined
28-1-1274 28-1-1273 28-1-1275 Unknown	Rein. Con. Girder Rein. Con. Arch Rein. Con. Arch Rein. Con. Slab	Stream cr. Stream cr. Stream cr. Stream cr.	24 24 42 32	44 56 39 24	1 1 1 1	20 20 20 20	Unknown Unknown Unknown Unknown	11.0 13.0 8.0 8.0	22 24 22 Unknown						$238,000	$118,000	$ 6,000	—	$362,000	$1500 per mile per year	6% of construction & maintenance costs	To be determined

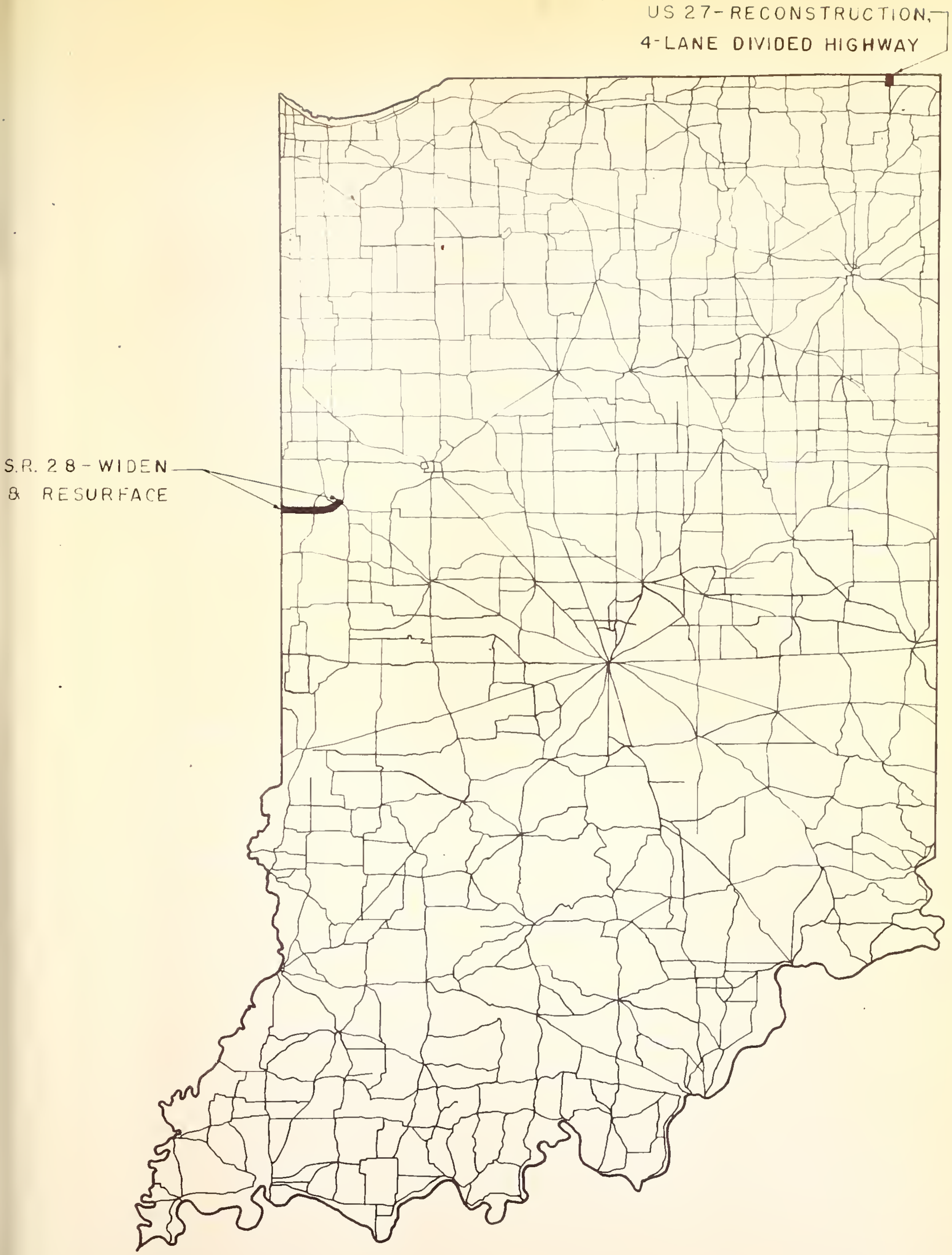


FIGURE 9 ILLUSTRATION OF NEEDS ON PRIMARY & SECONDARY STATE HIGHWAY SYSTEM

highway should be widened and resurfaced (shown in Column 23 from data in Columns 16 and 17 and width as noted in Column 6) and that five narrow bridges require replacement (Column 28). The amount of money to perform each of these improvements is indicated in columns 40, 41, 42 and 43. The annual costs of maintenance and administration are also included, and, when added to the total construction costs (Column 44), constitute the total financial needs for each section. Similar analysis was performed for every section of the State Highway System.

The road and street needs of counties and cities were also determined to complete the study of needs. Time and financial limitations made it impossible to inventory each of the 87,000 miles of county roads and city streets. Furthermore, the available records of construction as well as studies and plans for road and street improvements are inadequate. In addition, most counties and many cities have not classified their roads or streets and are doing little to provide a designated system of primary county roads and arterial city streets. This, in fact, is one of the big needs of county highways and city streets - the classification and orderly improvement of roads and streets and the collection and retention in an organized manner of road inventory information and data of concern to construction and operation.

In order to obtain an estimate of county road needs, data from two Indiana Counties were used as a sample. In these counties detailed information on road needs were evaluated after a classification of the county roads had been made and an inventory of the primary roads had been evaluated. The present roads were compared with the minimum road necessary to perform the service demanded and the total needs for the two counties in Indiana thus obtained. The needs in these two counties, together

with a study of county road needs in adjoining states as reported in their needs studies, provided the basis for an estimate of the county highway needs in Indiana.

The needs for city streets fall into two categories - those needs on streets that are highways under state administration and those needs on streets under city administration. In many Indiana cities the arterial streets of the city are the state highways. The needs of these routes were determined under the state highway needs study and are reported under that section of the report. These needs, in fact, constitute a big portion of state highway needs because much of the extremely expensive construction is in urban areas. Many miles of expressway are required in our major cities to eliminate the inadequacy of the existing and unexpanable street system.

The streets under city responsibility also have needs. These were evaluated by studying the network of streets in representative cities of each population class and determining the percentage of street mileage of each city that should be classified as arterial thoroughfares and local access streets. The per mile cost of improving the streets of a typical city to adequate condition as well as providing the additional capacity necessary was then determined from studies of such improvement that had been made by engineering organizations for a few of the cities, from estimates made by several city engineering departments, and from estimates made by state highway needs studies in adjacent and nearby states.

It is true that the estimates of county highway and city street needs are not based on evidence that is as complete as the information for state highways. It was not possible to obtain such complete information for this study and will not be possible until better data collection and

record keeping procedures are established by the counties and cities. The county and city needs as reported in this study, however, are based upon the best information available. _They are realistic and are believed to be substantially sound._

TYPICAL HIGHWAY NEEDS FOUND

All highways, state, county or city, need improvements for the same reasons. They become structurally deficient due to an inability to support the loads that move over them; they become deficient in capacity because of increasing volumes of traffic; they are unsafe because of restricted sight distance, sharp curves, blind intersections and many other characteristics; they wear out because of age.

On the state highway system the capacity factor requires that roads with traffic volumes exceeding 5000 vehicles a day should be multi-lane divided roads. On the basis of this requirement alone, the present Interstate and Primary Systems of Indiana require about 1100 miles of multi-lane divided roads and the Secondary System requires an additional 150 miles. Furthermore, within 20 years the roads carrying 3000 vehicles today will probably be carrying over 5000, and another 2000 miles of multi-lane divided highway will be required (See Figure 10). At present Indiana has about 300 miles of multi-lane divided pavements. An additional 950 miles of such construction are needed now and within the next 20 years another 2000 miles may be necessary.

Modern traffic also demands pavements with sufficient width to permit traffic to move safely and efficiently in each direction. New two-lane highways are build 24 feet wide. On our present rural state highway system only about 700 miles are that wide and over 3000 miles are less than 20 feet wide (See Figure 11).

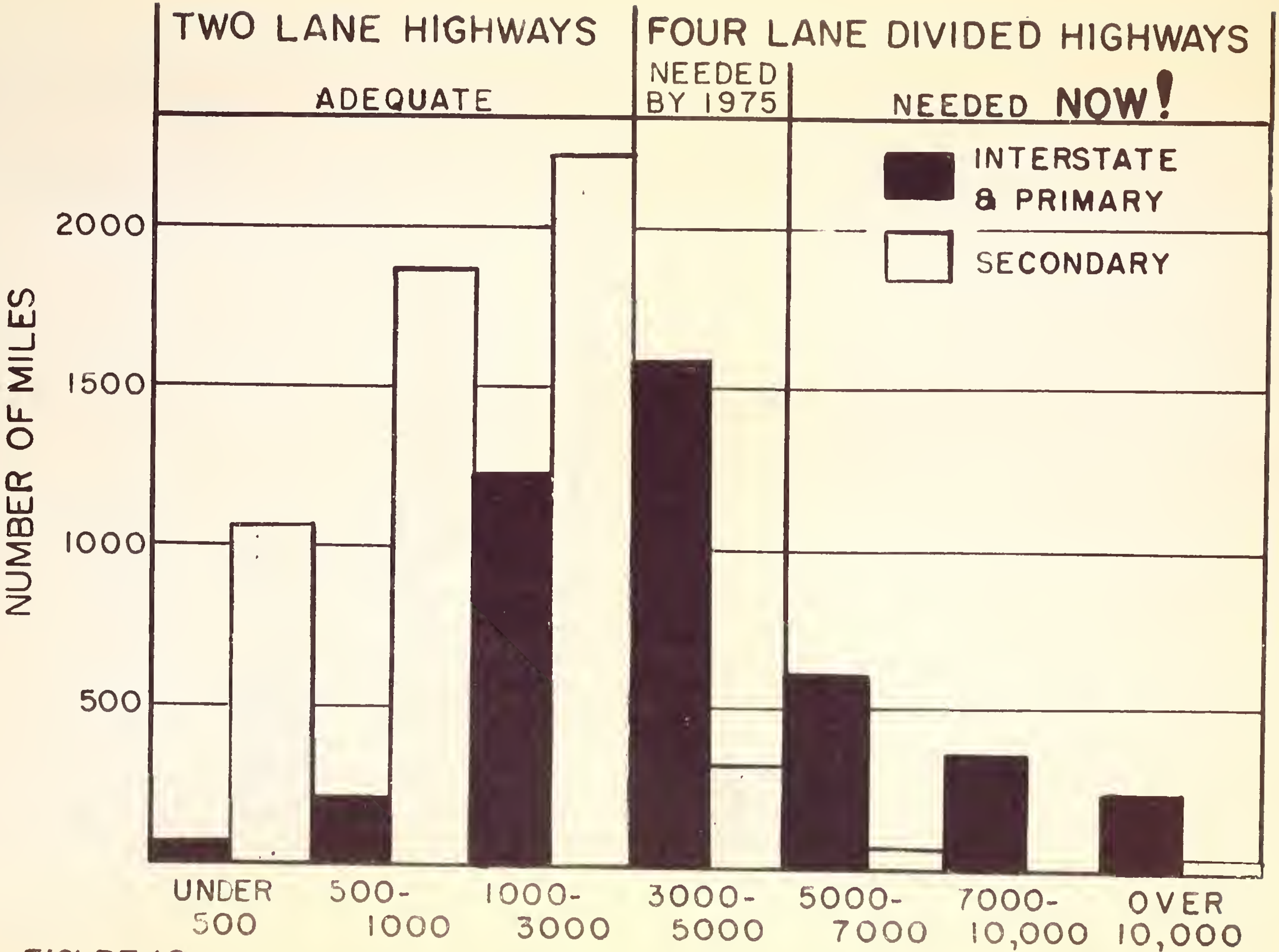


FIGURE 10

TRAFFIC VOLUMES ON THE RURAL STATE SYSTEM

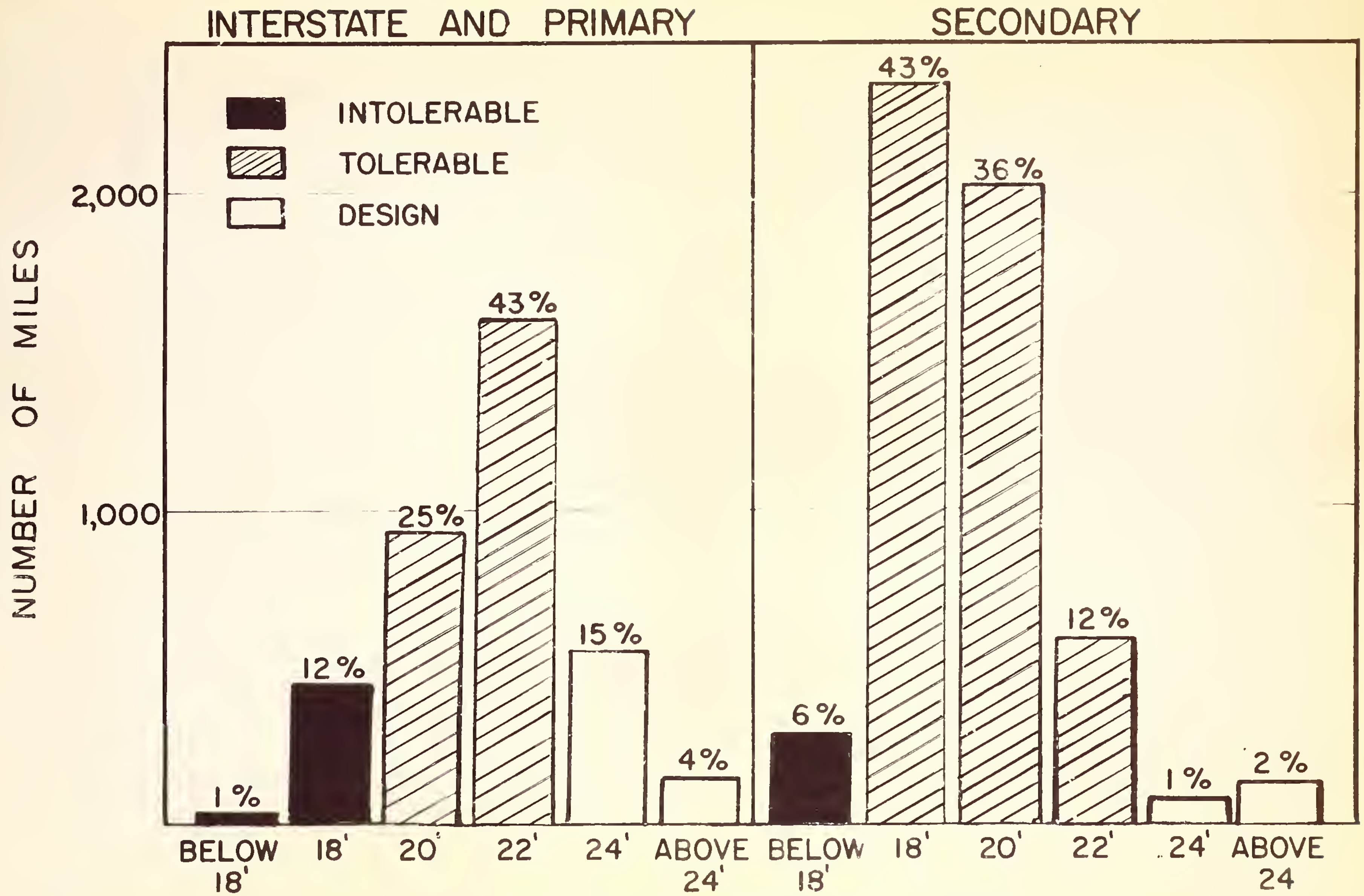


FIGURE 11

SURFACE WIDTHS ON 2 LANE RURAL HIGHWAYS

Many state highways and county roads are inadequate because narrow bridges and culverts limit their capacity and contribute to the accident problem. The State Highway Department has been conducting an effective program of widening culverts and narrow bridges of short span length. Much, however, remains to be done. Early in 1955 over 1500 bridges under 25 feet in width remained in use on two-lane rural state highways (See Figure 12). Very few of those have been widened in the past year. Thousands of additional narrow culverts and bridges exist on county roads.

The development of Indiana's portion of the Interstate System is one of the major needs. This system comprises almost 1100 miles of Indiana's most important highways and very little of it has been developed to acceptable standards. The highways in this system will provide for through-trip movement and must have the capacity to move large volumes of traffic long distances economically and with a minimum of delay and inconvenience. They will provide for national defense and serve as primary highway routes for Indiana industry, commerce, and agriculture. In order to possess all of these characteristics and retain them for many years these highways must be controlled access facilities and built to the highest standards. These highways could not continue to perform their function if they were constructed and then cluttered by many points of entrance and exit. The present Interstate and Primary Systems of Indiana have an average of almost 16 entrances per mile with some individual miles near cities having over 100 entrances (see Figure 13). As a result most of the mileage of Interstate Highways in Indiana must be relocated and constructed.

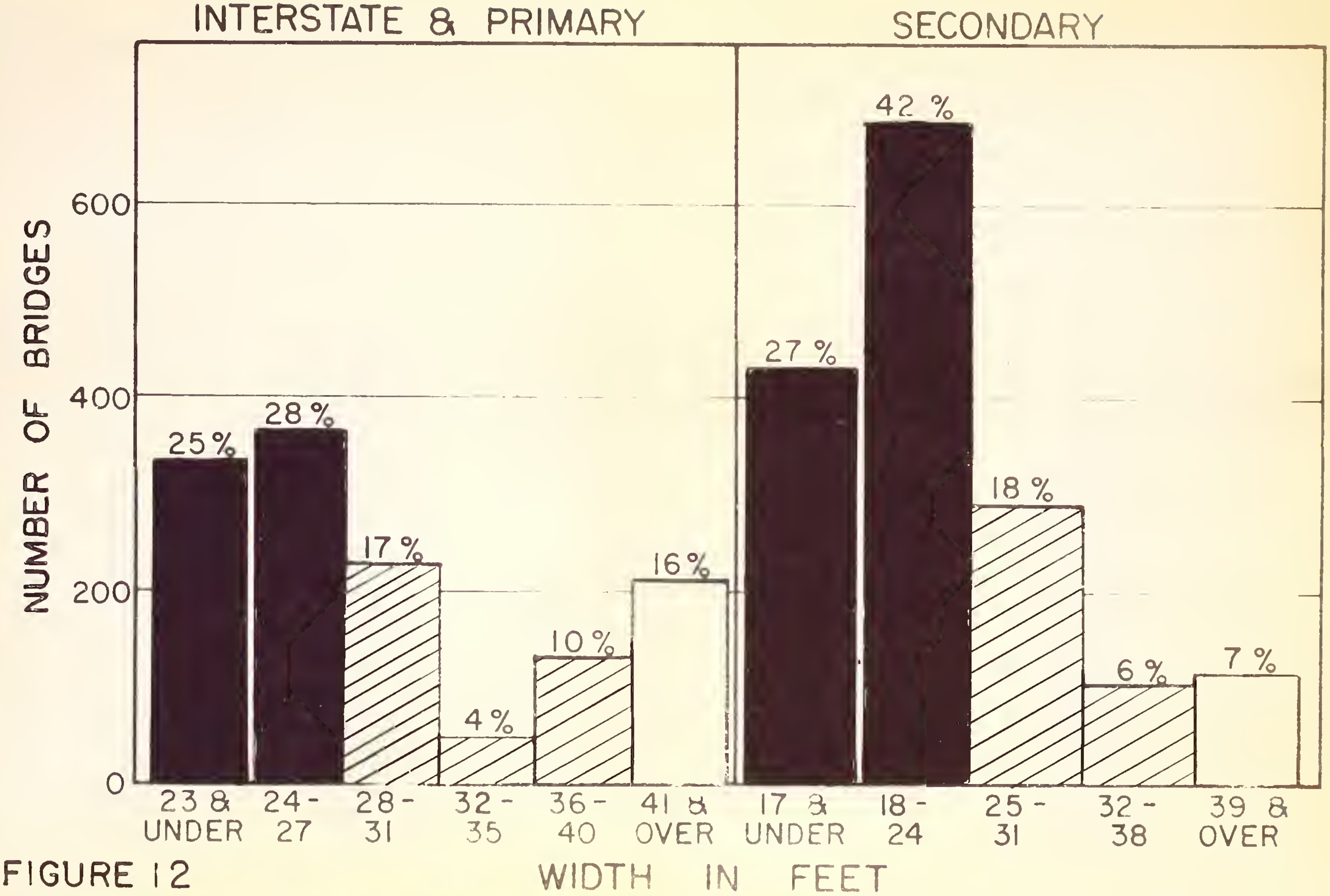


FIGURE 12

WIDTH OF BRIDGES ON 2-LANE RURAL HIGHWAYS

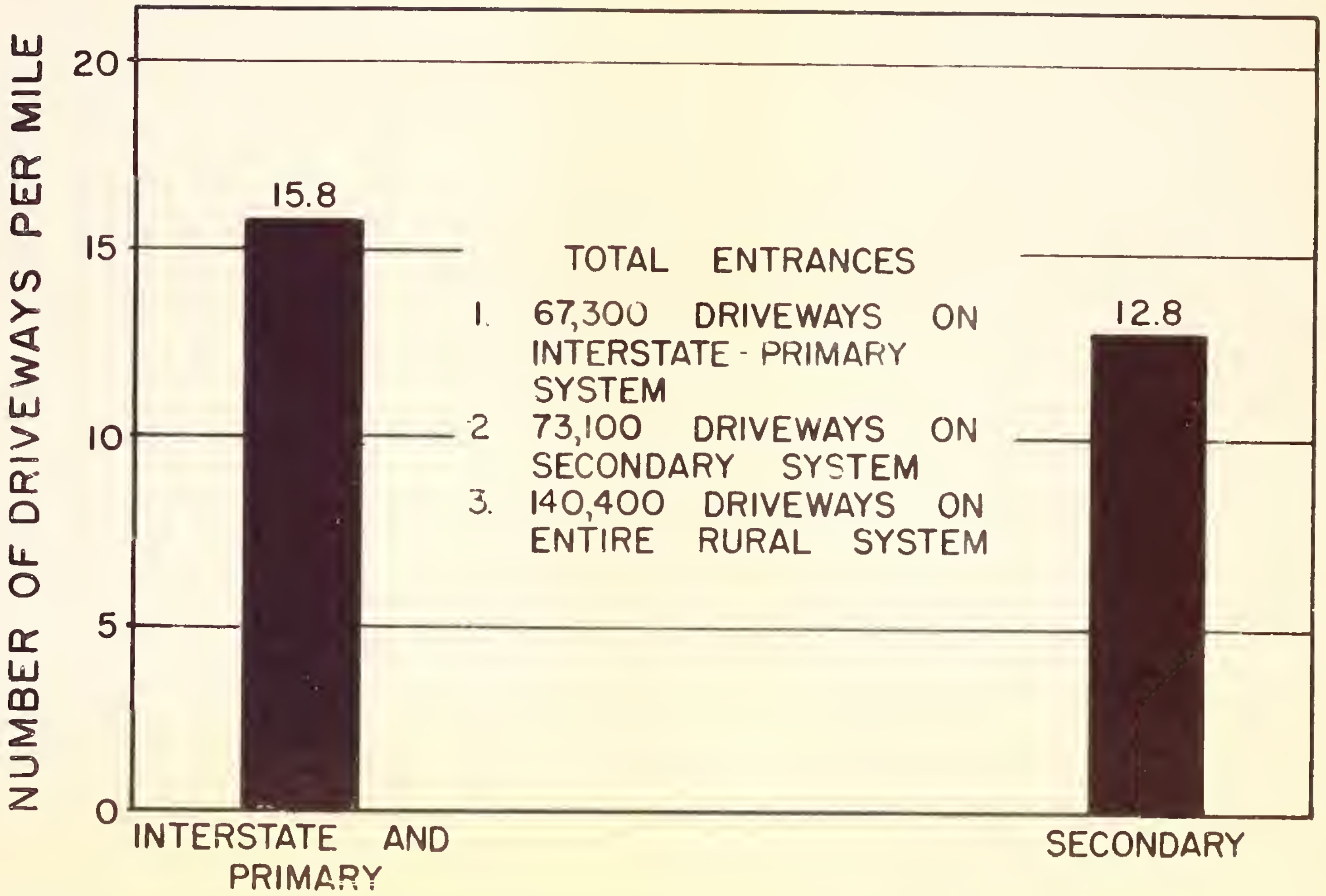


FIGURE 13 FREQUENCY OF DRIVEWAYS ON RURAL STATE SYSTEM

In the counties the providing of an adequate base for roads and the hard-surfacing of many miles of heavily traveled primary roads is still a major problem. As mentioned before narrow and weak bridges can be found in every county of the state. The problem of construction and maintainence of new roads in developments near urban areas is a serious one that deserves action

The travel in and near urban areas constitutes a major share of the travel on all roads Every city has streets that are not capable of moving the heavy volumes that move over them. Congestion and accidents are common enemies and together with parking problems present a difficult and costly condition.

Furthermore the cost of providing additional capacity by street widening or expressway building is very expensive. The problem does not stop there Many miles of local access streets require reconstruction and many more miles require resurfacing and better maintenance. The development of streets in our expanding cities is a further problem and a real one for these units of government.

The above discussions present a few examples of the needs of the Indiana Highway System. Many others exist and were included in the study In fact almost every mile of highway in Indiana is now, or will be in need of improvement or reconstruction within the next fifteen years. This is not a surprising fact because it is also a fact that we have not kept our highway system adequately in the past and highways do wear out, disentegrate, and become obsolete.

[illegible] Sodded Ditch Side of Highway ...

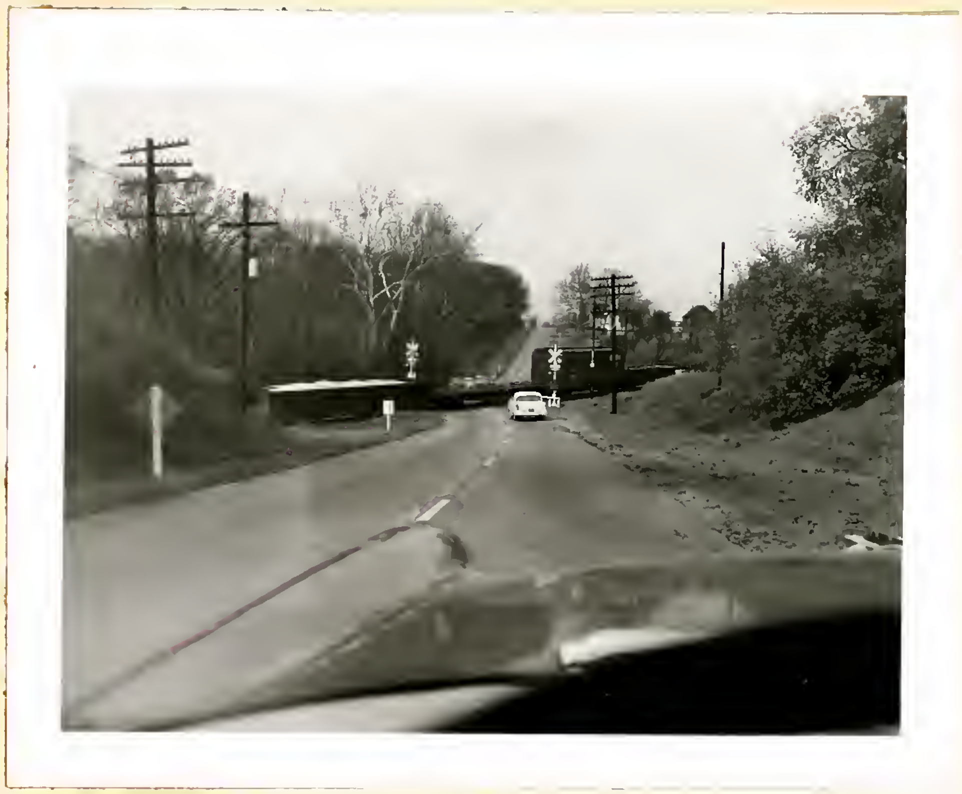
For Width of Pavement and Shoulders ...

Roadside Developments ...

Highway Conditions ...

Drainage ...

Structures ...



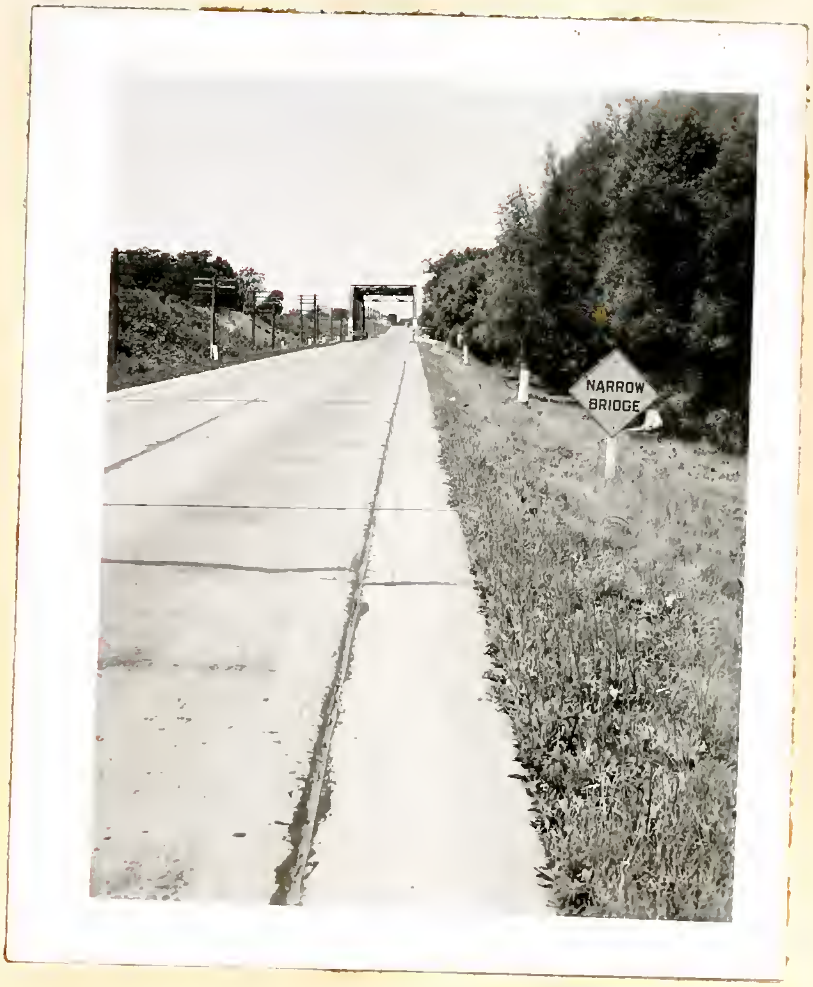
Railroad Crossings

State Highways were found to have inadequate shoulders and deteriorated pavements ....

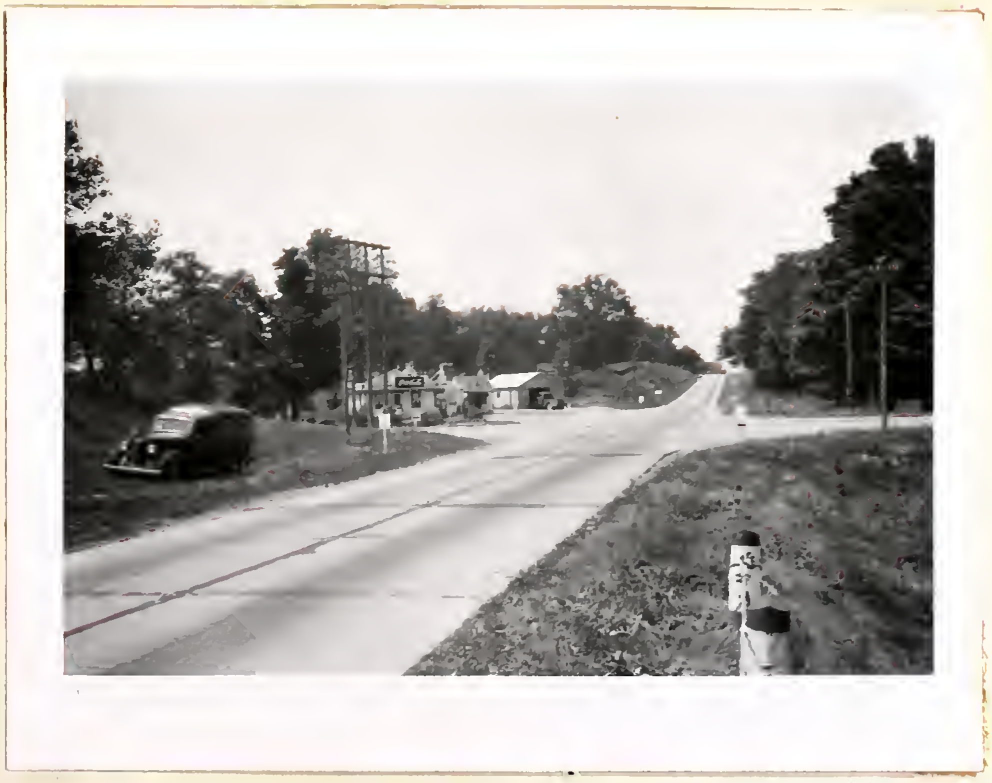
Insufficient Pavement Width...

Inadequate Sight Distances ...

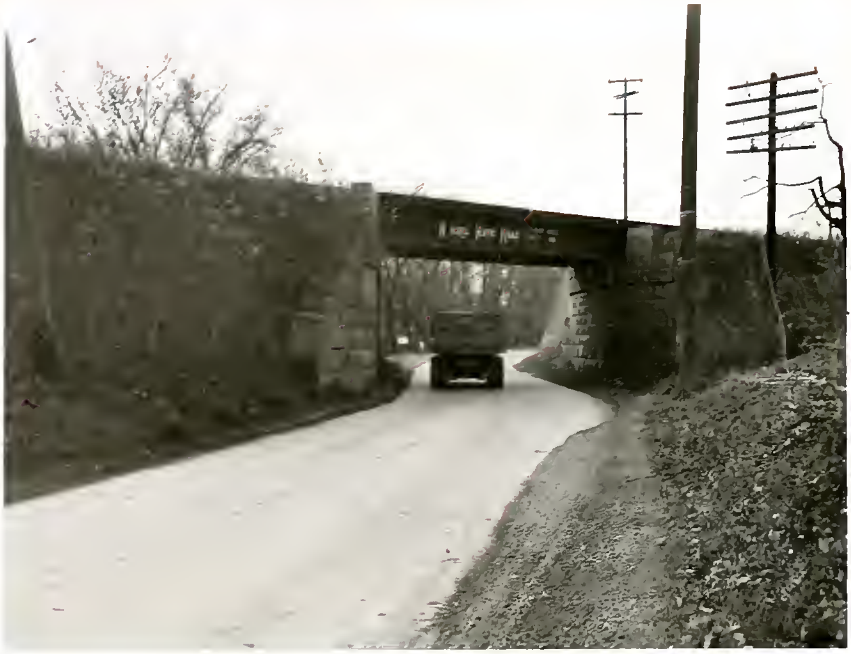
Lack of Capacity ...



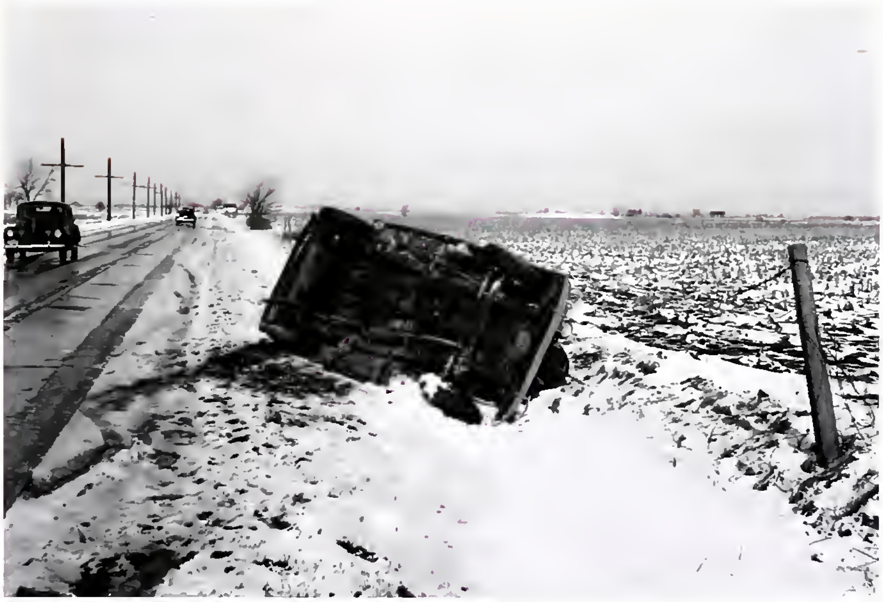
Narrow Bridges ...



Other Deficiencies Such as Dangerous Intersections ...



Narrow Underpasses ...

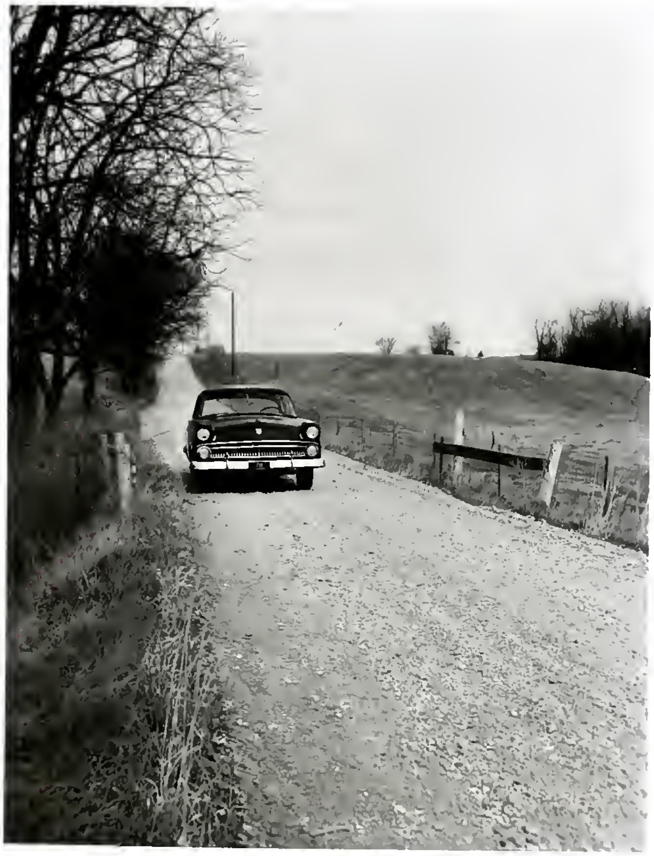


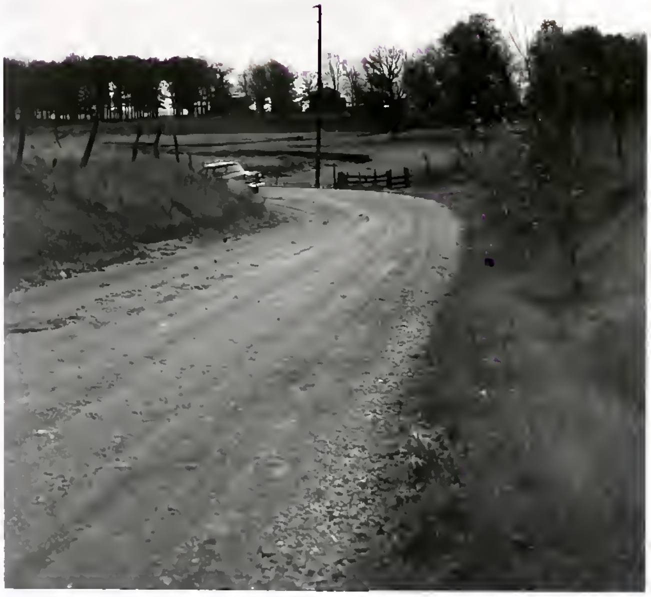
Which Make Driving Hazardous ...

County Roads were found to be narrow ...

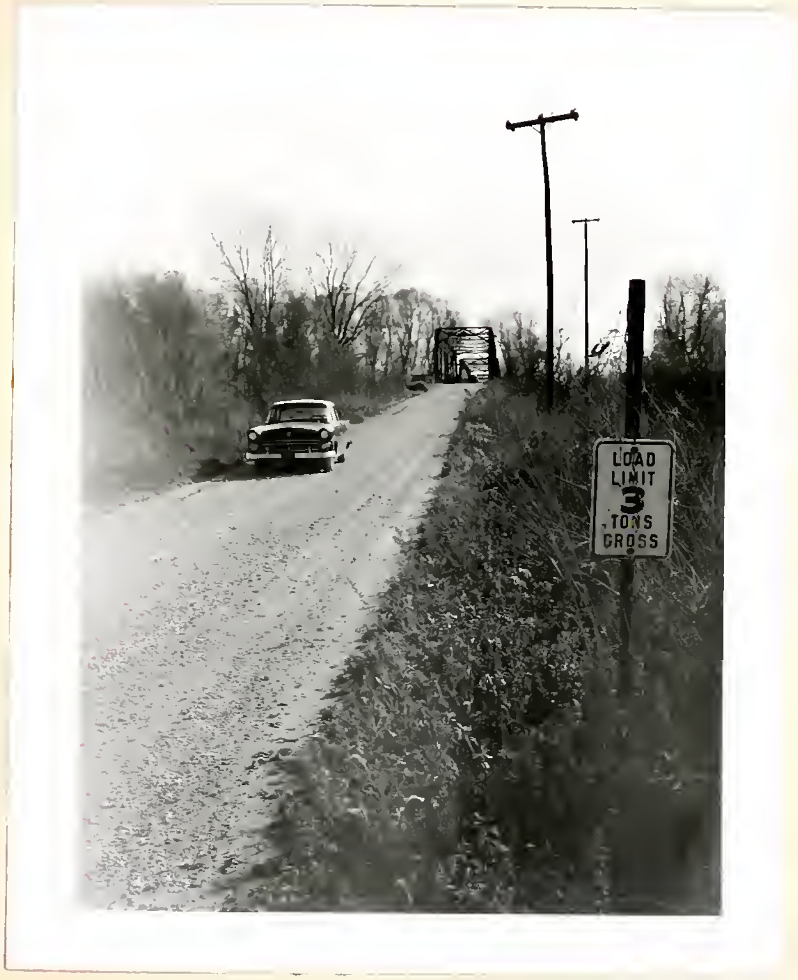
In Need of Weather-proof Surfaces ...

Narrow Culverts and
Shoulders ...

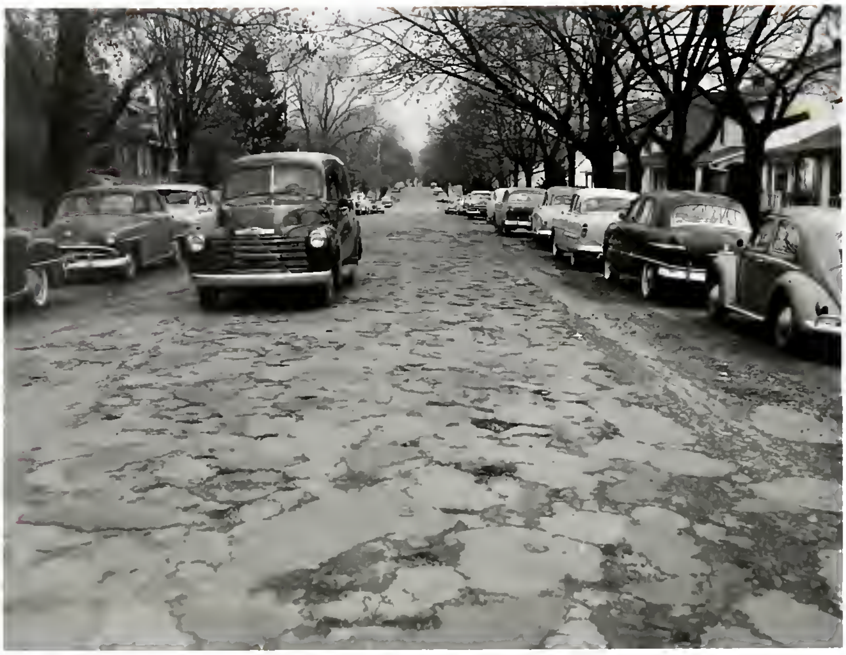




Blind Curves ...



Inadequate and Unsafe Bridges ...



City Streets Need Maintenance ...

More Off-Street Parking and Loading ...

[illegible]

More Capacity ...

And Elimination of Bottlenecks ...

COST OF NEEDS

The actual cost of the physical needs reported in this study has been divided into three general classes:

1. Backlog of Needs
2. Accumulation of Needs as Highways Become Deficient
3. Maintenance Needs

The backlog of needs refers to the amount of money needed to improve all inadequate highways, bridges, and railroad crossings to tolerable or design standards. It refers explicitly to the existing needs on the Indiana Highway Systems that have accumulated over the years because of the ever increasing gap between an adequate and an inadequate highway system. The backlog of needs constitutes a great percentage of the total cost and is therefore of considerable importance.

The accumulation of needs as highways become deficient refers to the cost of construction, or money needed, to keep the highway system adequate as additional highway needs accrue from year to year. Highways that are now tolerable will become intolerable as time progresses because of inevitable wearing out and obsolescence.

Also included in the future needs are replacement and stop-gap costs. Replacement costs are caused by needs which develop on improved sections of highway before such a need is anticipated. For example, a new bridge could be destroyed by a destructive flood or a relatively new section of highway may need further improvement because of an unforeseen increase in the movement of vehicle travel that could be caused by the construction

of a new industry. Over a short period of time replacement costs for a new highway are quite small, but they increase progressively as the highway becomes older.

Even at an accelerated rate of construction, it will be necessary to delay many projects for several years before they are reconstructed because of the tremendous backlog of needs. Therefore, some of these delayed projects must be improved in some manner to adequately serve traffic until the time that they are programmed for reconstruction. This additional construction is called the stop-gap needs and the cost of these needs was found to be approximtely 9 percent of the total cost of construction over a period of 15 years

The maintenance needs refer to the cost involved in the general housekeeping and up-keep of the highway facilities Maintenance cost that are indicated for the county, city, and state highway systems do not include the cost of betterments, such as the cost on construction of low type surfaces and other items which are a capital improvement, but only the costs involved in direct and indirect maintenance.

Included in the cost of maintenance is the total cost of administration involved in the construction and maintenance programs. Among the administrative costs are such items as rent and up-keep of highway offices, salaries for clerks and typists, costs of plan and blueprint reproduction, and office supplies. This cost was found to be approximately 6 percent of total cost of the construction and maintenance programs.

In order to program the total highway needs so that this huge quantity of work might be completed in a reasonable time and also to

efficiently use all available engineering and construction manpower, a program period of 15 years was used. The Federal Aid Highway Act of 1956 requires that the Interstate System be constructed in 15 years, giving additional emphasis to a 15 year program period.

A shorter program time could be used. However, the average annual expenditures necessary to eliminate the total needs would be greater and perhaps beyond the revenue capacity of Indiana. Of course the shorter the program period, the greater the benefits to the highway user in the form of efficient operation of his vehicle, time savings, reduced accidents, and other benefits. Therefore, the time required to complete the program is of the essence, but on the other hand, the highway system can not be rebuilt immediately.

The needs as shown in Table II for each system of highway are based on 1955 prices of construction. Adjustment for possible future price trends has not been attempted.

The accumulation of needs as state highways become inadequate are presented as average annual needs. Actually a larger proportion of these needs will accumulate during the first half of the program period than during the latter half. This phase of the study is continuing and information on the accumulation of needs for each of the future years will be available in a few months.

The cost of needs indicated in Table 2 for the State Highway System may be subject to minor revisions because this system is still under further study. However, final cost information is expected to be very close to those that are given in the report.

TABLE II COST SUMMARY OF HIGHWAY NEEDS

COUNTY HIGHWAY SYSTEM

Classification of Needs	Total Cost for 15-Year Program	Average Annual Cost
1 Existing Backlog of Needs	$273,645,000	$ 18,243,000
2. Accumulation of Needs As Highways Become Deficient	235,905,000	15,727,000
3 Maintenance	481,245,000	32,083,000
Total	$990,795,000	$ 66,053,000

CITY STREET SYSTEM*

Classification of Needs	Total Cost for 15-Year Program	Average Annual Cost
1. Existing Backlog of Needs	$271,560,000	$ 18,104,000
2. Accumulation of Needs As Highways Become Deficient	172,125,000	11,475,000
3. Maintenance	206,250,000	13,750,000
Total	$649,935,000	$ 43,329,000

STATE HIGHWAY SYSTEM: INTERSTATE SYSTEM (RURAL AND URBAN)

Classification of Needs	Total Cost for 15-Year Program	Average Annual Cost
1. Existing Backlog of Needs	$881,543,000	$ 58,769,533
2. Accumulation of Needs As Highways Become Deficient	9,044,000	602,934
3. Maintenance	79,670,000	5,311,333
Total	$970,257,000	$ 64,683,800

* Does not include cost of State Highways in Urban Areas

TABLE II (CONTINUED)

STATE HIGHWAY SYSTEM: PRIMARY AND SECONDARY
(RURAL AND URBAN)

Classification of Needs	Total Cost for 15-Year Program	Average Annual Cost
1. Existing Backlog of Needs	$ 734,333,000	$ 48,955,533
2. Accumulation of Needs As Highways Become Deficient (Approximate)	640,871,000	42,724,733
3 Maintenance	374,217,000	24,947,800
Total	$ 1,749,421,000	$ 116,628,066
STATE HIGHWAY SYSTEM TOTAL	$ 2,719,678,000	$ 181,311,866

TOTAL NEEDS FOR COUNTY, CITY AND STATE HIGHWAY SYSTEMS

Classification of Needs	Total Cost for 15-Year Program	Average Annual Cost
1 Existing Backlog of Needs	$ 2,161,081,000	$ 144,072,067
2. Accumulation of Needs As Highways Become Deficient (Approximate)	1,057,945,000	72,529,666
3. Maintenance	1,141,382,000	76,092,133
Total	$ 4,360,408,000	$ 290,693,866

Indiana's State Highway System Needs Hundreds of Miles of Multi-Lane Divided Highways ...

With Modern Interchanges ...

The Reconstruction of Hundreds of Miles of Two-Lane Pavements ...

And Many Bridges are Required ...

Good County Roads ...

And City Streets are Required.